Wepawaug River

Watershed Summary

WATERSHED DESCRIPTION AND MAPS

The Wepawaug River watershed covers an area of approximately 12,743 acres in the southern coastal area of Connecticut (Figure 1). There are several municipalities located at least partially in the watershed, including the City of Milford and the Towns of Orange and Woodbridge, CT.

The Wepawaug River watershed includes five segments impaired for recreation due to elevated bacteria levels. These segments were assessed by Connecticut Department of Energy and Environmental Protection (CT DEEP) and included in the CT 2010 303(d) list of impaired waterbodies. An excerpt of the Integrated Water Quality Report is included in Table 1 to show the status of some of the other waterbodies in the watershed (CT DEEP, 2010).

Wepawaug River (Segment 5) (CT5307-00_05) begins at the outlet of the Center Street Pond outlet dam just upstream of the Center Road (Route 14) crossing, flows south, and ends in a wooded area east of the Racebrook Road (Route 114) and Milan Road intersection in Woodbridge. Wepawaug River (Segment 5) is 0.99 miles long and is located within the Town of Woodbridge. Wepawaug River (Segment 4) (CT5307-00-04) begins at the downstream terminus of Wepawaug River (Segment 5), continues south into Orange, and ends at the inlet to the Wepawaug Reservoir. Wepawaug River (Segment 4) is 3.05 miles long and is located within Towns of Woodbridge and Orange (Figure 2).

Wepawaug River (Segment 3) (CT5307-00_03) begins at the downstream terminus of Wepawaug River (Segment 4) at the inlet to the Wepawaug Reservoir, flows south, and ends at the inlet to Lake Wepawaug east of Arrowhead Drive and west of Grassy Hill Road (Route 121) in Orange. Wepawaug River (Segment 3) is 2.33 miles long and is located entirely within the Town of Orange. Wepawaug River (Segment 2) (CT5307-00_02) begins at the inlet to Lake Wepawaug between Route 121 and Route 15 in Orange, flows south into Milford, and ends at the US Route 1 crossing in Milford. This segment is 4.2 miles long and is located in the Town of Orange and the City of Milford. Wepawaug River (Segment 1)

Impaired Segment Facts

Impaired Segments, Lengths (miles), and Water Quality Classification:

1. Wepawaug River (Segment 1) (CT5307-00_01); 0.77; A
2. Wepawaug River (Segment 2) (CT5307-00_02); 4.20; A
3. Wepawaug River (Segment 3) (CT5307-00_03); 2.33; A
4. Wepawaug River (Segment 4) (CT5307-00_04); 3.05; AA
5. Wepawaug River (Segment 5) (CT5307-00_05); 0.99; AA

Municipalities: Milford, Orange, Woodbridge

Designated Use Impairment: Recreation

Sub-regional Basin Name and Code: Wepawaug River, CT5307

Regional Basin: South Central Western Complex

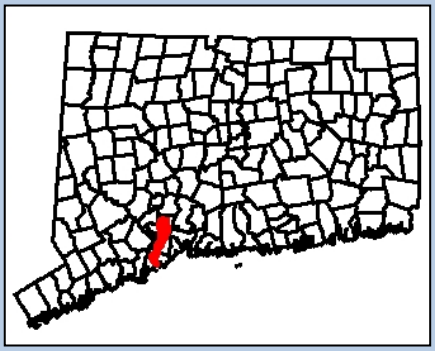
Major Basin: South Central Coast

Watershed Area (acres): 12,743

MS4 Applicable? Yes

Applicable Season: Recreation Season (May 1 to September 30)

Figure 1: Watershed location in Connecticut



(CT5307-00_01) begins at the US Route 1 crossing in Milford, flows south through dense residential development, and ends at the Route 162 crossing just above the tidal influence of Milford Harbor. This segment is 0.77 miles long and is entirely within the City of Milford.

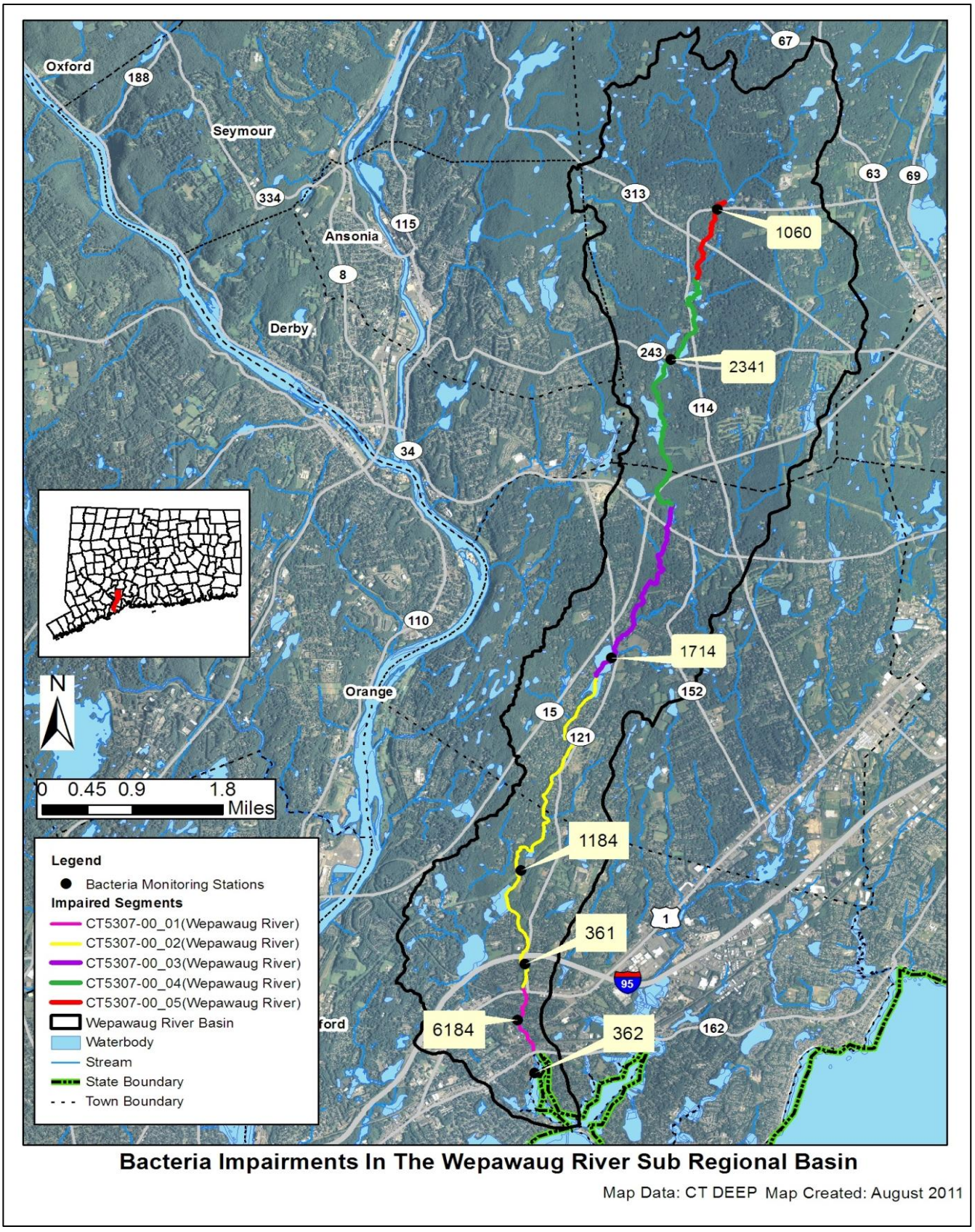
Segments 1, 2, and 3 of the Wepawaug River have a water quality classification of A. Designated uses include potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. Segments 4 and 5 of the Wepawaug River have a water quality classification of AA. Designated uses include existing or proposed drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. These segments are impaired due to elevated bacteria concentrations, affecting the designated use of recreation. As there are no designated beaches on Segments 1, 2, and 3, the specific recreation impairment is for non-designated swimming and other water contact related activities. There are designated beaches on Segments 4 and 5, and the specific recreation impairment is for designated swimming.

Table 1: Impaired segment and nearby waterbodies from the Connecticut 2010 Integrated Water Quality Report

Waterbody ID	Waterbody Name	Location	Miles	Aquatic Life	Recreation	Fish Consumption
CT5307-00_01	Wepawaug River-01	From Wepawaug Pond outlet dam (head of tide) at Milford Avenue (Route 162) crossing, US to Route 1 crossing, Milford. Segment includes Wepawaug Pond and City Pond portions on river.	0.77	U	NOT	FULL
CT5307-00_02	Wepawaug River-02	From Route 1 crossing, Milford, US to Lake Wepawaug inlet, Orange. Segment includes Lake Wepawaug portion on river.	4.2	U	NOT	FULL
CT5307-00_03	Wepawaug River-03	From inlet to Lake Wepawaug, US to inlet to Wepawaug Reservoir (US of Route 34 crossing), Orange. Segment includes Wepawaug Reservoir portion of river.	2.33	FULL	NOT	FULL
CT5307-00_04	Wepawaug River-04	From inlet to Wepawaug Reservoir, Orange, US to area east of Racebrook Road (Route 114), perpendicular to Milan Road, Woodbridge.	3.05	U	NOT	FULL
CT5307-00_05	Wepawaug River-05	From area east of Racebrook Road (Route 114), perpendicular to Milan Road, US to headwaters at Center Street Pond outlet dam (on Keenes Ice Pond), just US of Center Road (Route 14) crossing, Woodbridge,	0.99	U	NOT	FULL

Shaded cells indicate impaired segment addressed in this TMDL
FULL = Designated Use Fully Supported
NOT = Designated Use Not Supported
U = Unassessed

Figure 2: GIS map featuring general information of the Wepawaug River watershed at the sub-regional level



Land Use

Existing land use can affect the water quality of waterbodies within a watershed (USEPA, 2011c). Natural processes, such as soil infiltration of stormwater and plant uptake of water and nutrients, can occur in undeveloped portions of the watershed. As impervious surfaces (such as rooftops, roads, and sidewalks) increase within the watershed landscape from commercial, residential, and industrial development, the amount of stormwater runoff to waterbodies also increases. These waterbodies are negatively affected as increased pollutants from failing and insufficient septic systems, oil and grease from automobiles, and sediment from construction activities become entrained in this runoff. Agricultural land use activities, such as fertilizer application and manure from livestock, can also increase pollutants in nearby waterbodies (USEPA, 2011c).

As shown in Figures 3 and 4, the Wepawaug River watershed consists of 43% forest, 49% urban area, 3% agriculture, and 4% water. Portions of the watershed in Milford, Orange, and Woodbridge, particularly near Wepawaug River (Segments 1, 2, and 5) are dominated by developed urban areas. Several small agriculture operations are located adjacent to the Wepawaug River near the downstream portion of Wepawaug River (Segment 3), along portions of Wepawaug River (Segment 2) in Orange and Milford, and near the upstream portion of Wepawaug River (Segments 4 and 5). Most of the area surrounding Wepawaug River (Segment 4) in Woodbridge and northern Orange is dominated by forested land use (Figure 4).

Figure 3: Land use within the Wepawaug River watershed

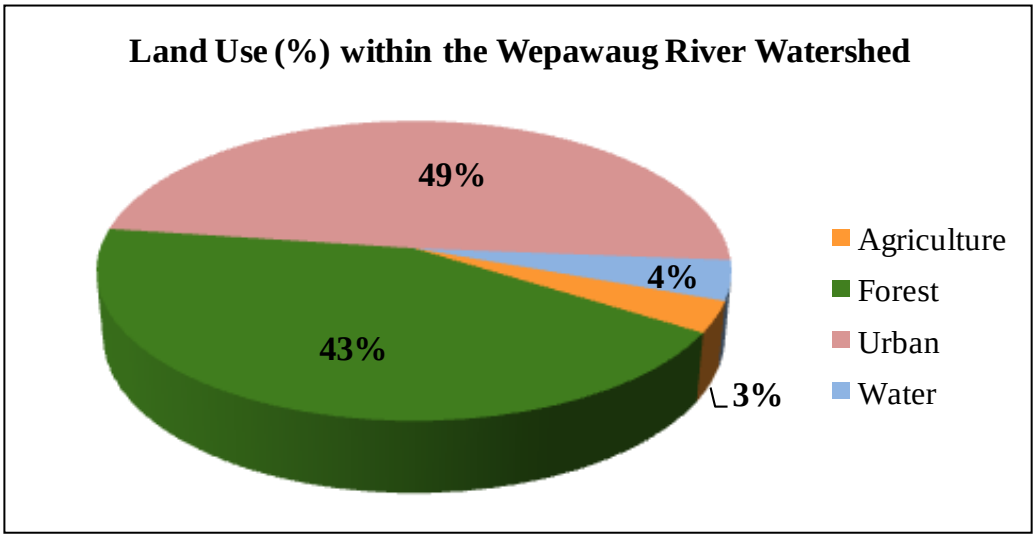
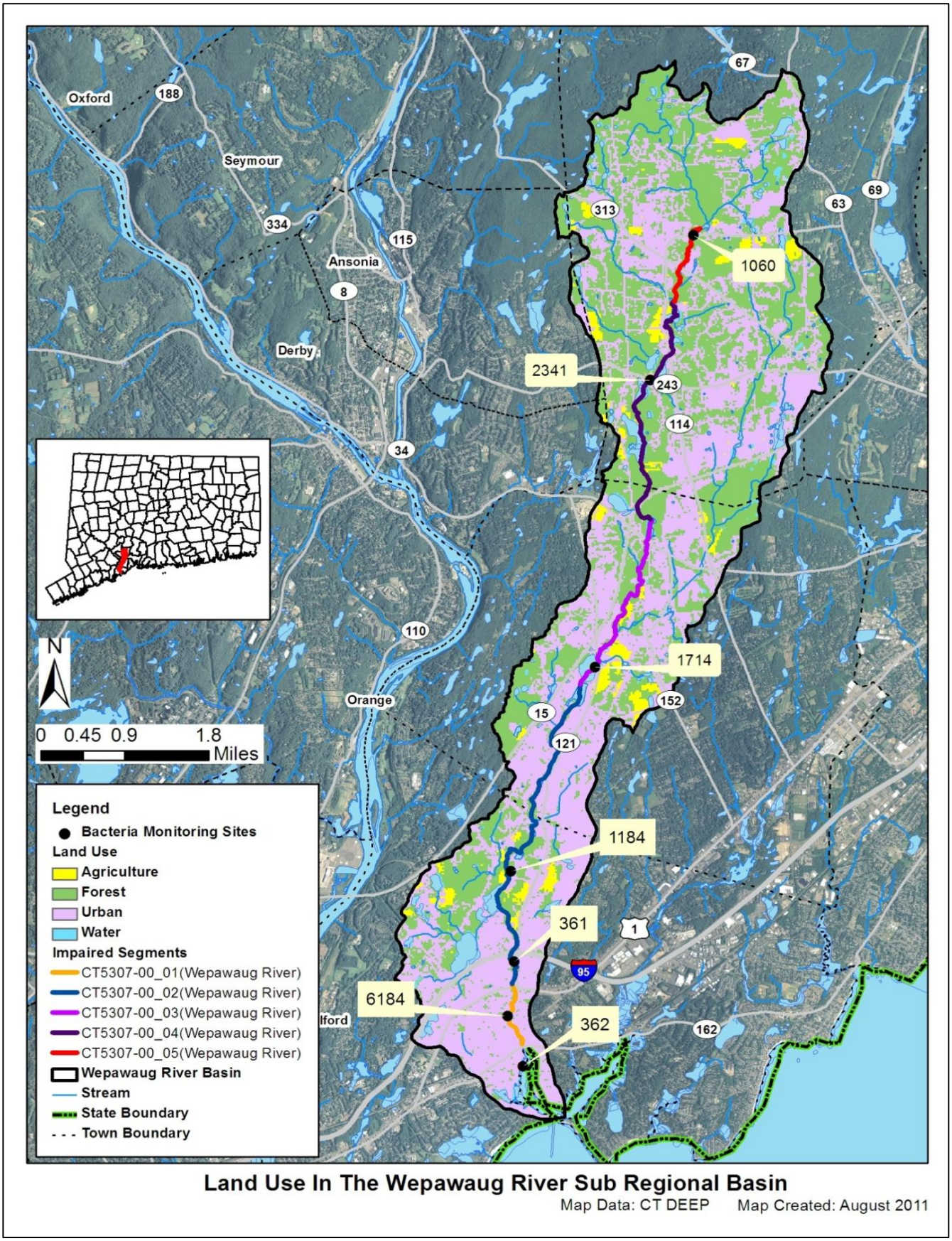


Figure 4: GIS map featuring land use for the Wepawaug River watershed at the sub-regional level



WHY IS A TMDL NEEDED?

E. coli is the indicator bacteria used for comparison with the CT State criteria in the CT Water Quality Standards (WQS) (CTDEEP, 2011). All data results are from CT DEEP, USGS, Bureau of Aquaculture, or volunteer monitoring efforts at stations located on the impaired segments.

Table 2: Sampling station location description for the impaired segments in the Wepawaug River watershed (stations organized downstream to upstream)

Waterbody Name	Station	Station Description	Municipality	Latitude	Longitude
Wepawaug River (Segment 1) (CT5307-00_01)	362	Route 162	Milford	41.219142	-73.055342
	6184	100 West River Road (yellow house)	Milford	41.227290	-73.058610
Wepawaug River (Segment 2) (CT5307-00_02)	361	Walnut Street	Milford	41.236008	-73.057258
	1184	Eisenhower Park	Milford	41.250556	-73.058056
Wepawaug River (Segment 3) (CT5307-00_03)	1714	Downstream Route 121	Orange	41.28347	-73.040853
Wepawaug River (Segment 4) (CT5307-00_04)	2341	Route 243	Woodbridge	41.3297	-73.0296
Wepawaug River (Segment 5) (CT5307-00_05)	1060	Upstream of Route 114 crossing	Woodbridge	41.35306	-73.020833

Wepawaug River (Segments 1, 2, and 3) are Class A freshwater rivers. Their applicable designated uses are potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, and industrial and agricultural water supply. Wepawaug River (Segments 4 and 5) are Class AA freshwater rivers. Their applicable designated uses areexisting or proposed drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, and industrial and agricultural water supply. Water quality analyses were conducted using data from two sampling locations (Stations 6184 and 362) on Wepawaug River (Segment 1), two sampling locations (Stations 1184 and 361) on Wepawaug River (Segment 2), one sampling location on Wepawaug River (Segment 3) (Station 1714), one sampling location on Wepawaug River (Segment 4) (Station 2341), and one sampling location on Wepawaug River (Segment 5) (Station 1060).

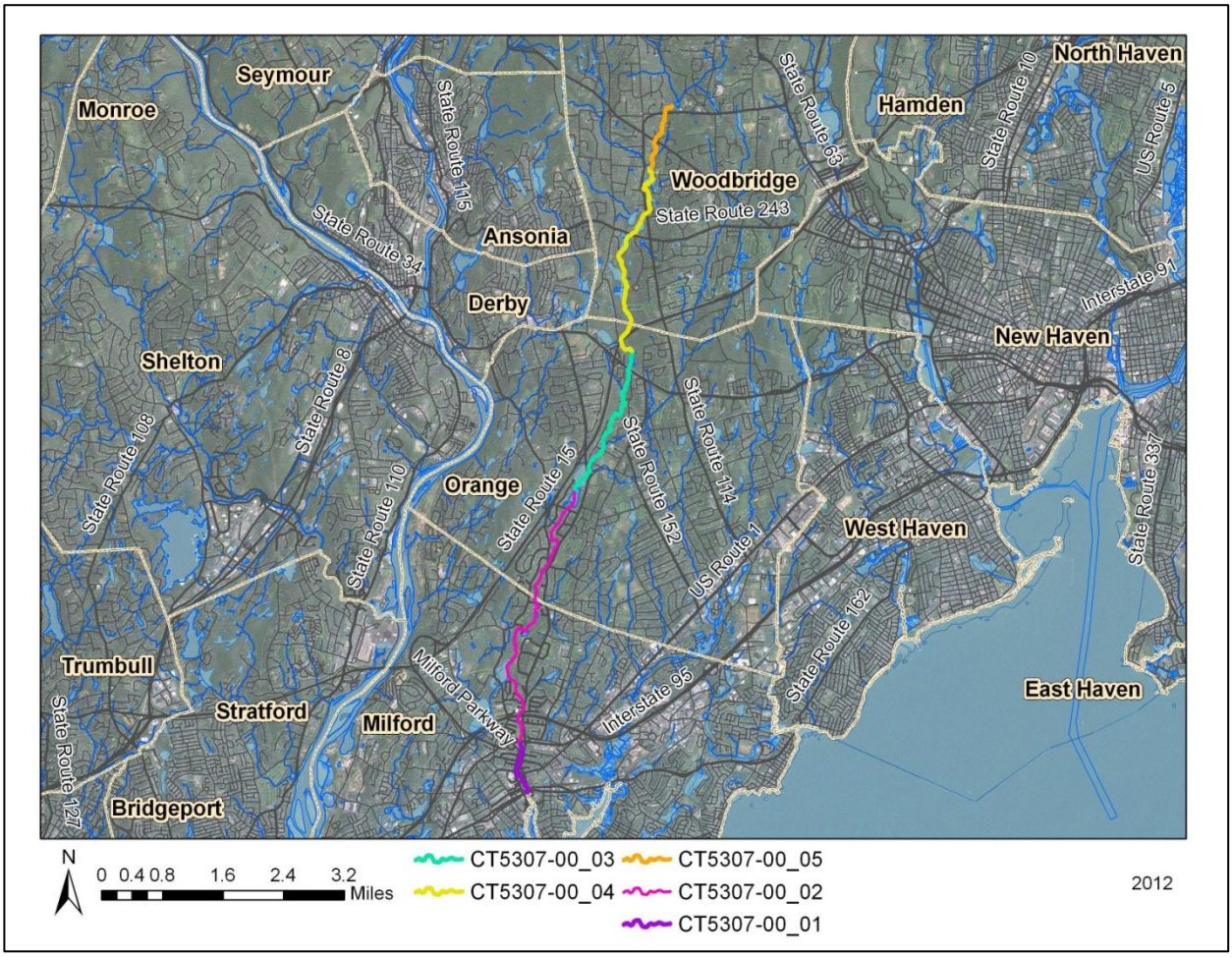
Water quality criteria for *E. coli*, along with bacteria sampling results from 1998, 2003, and 2010, are presented in Table 12 for Wepawaug River (Segment 1), results from 1998 and 2010 are presented in Table 13 for Wepawaug River (Segment 2), results from 2010-2011 are presented in Table 14 for Wepawaug River (Segment 3), results from 2010-2011 are presented in Table 15 for Wepawaug River (Segment 4), and results from 2010-2011 are presented in Table 16 for Wepawaug River (Segment 5). For Wepawaug River (Segment 1), the annual geometric mean was calculated for Station 361, and it exceeded the WQS for *E. coli* in 1998 and 2010. Single sample values exceeded the WQS for *E. coli* multiple times in 1998 and 2010 at Station 361, and on the single sample taken in 2003 for Station 1184. For Wepawaug River (Segment 2), single sample values for Station 6184 exceeded the WQS for *E. coli* multiple times in 2010. The annual geometric mean also exceeded the WQS for *E. coli* in 2010. The only sample taken at Station 362 in 1998 exceeded the WQS for *E. coli.* For Wepawaug River (Segment 3), single sample values for Station 1714 exceeded the WQS for *E. coli* twice in 2010 and once in 2011. The

annual geometric mean was calculated for Station 1714 and exceeded the WQS for *E. coli* in 2010 and 2011. For Wepawaug River (Segment 4), single sample values for Station 2341 exceeded the WQS for *E. coli* three times in 2010 and twice in 2011. The annual geometric mean was calculated for Station 2341 and exceeded the WQS for *E. coli* in both 2010 and 2011. For Wepawaug River (Segment 5), single sample values for Station 1060 exceeded the WQS for *E. coli* on all sampling dates in 2010, and once in 2011. The annual geometric mean was calculated for Station 1060 and exceeded the WQS for *E. coli* in both 2010 and 2011.

To aid in identifying possible bacteria sources, the geometric mean was also calculated for each station for wet-weather and dry-weather sampling days, where appropriate (Tables 12-16). Geometric mean values during both wet and dry-weather exceeded the WQS for *E. coli* at Station 361 on Wepawaug River (Segment 1), Station 6184 on Wepawaug River (Segment 2), Station 1714 on Wepawaug River (Segment 3), Station 2341 on Wepawaug River (Segment 4), and Station 1060 on Wepawaug River (Segment 5). The geometric mean values for dry-weather were higher than wet-weather for Station 361 on Wepawaug River (Segment 1), Station 6184 for Wepawaug River (Segment 2), Station 1714 for Wepawaug River (Segment 3), and Station 1060 for Wepawaug River (Segment 5).

Due to the elevated bacteria measurements presented in Tables 12-16, these impaired segments did not meet CT's bacteria WQS, were identified as impaired, and were placed on the CT List of Waterbodies Not Meeting Water Quality Standards, also known as the CT 303(d) Impaired Waters List. The Clean Water Act requires that all 303(d) listed waters undergo a TMDL assessment that describes the impairments and identifies the measures needed to restore water quality. The goal is for all waterbodies to comply with State WQS.

Figure 5: Aerial map of the Wepawaug River



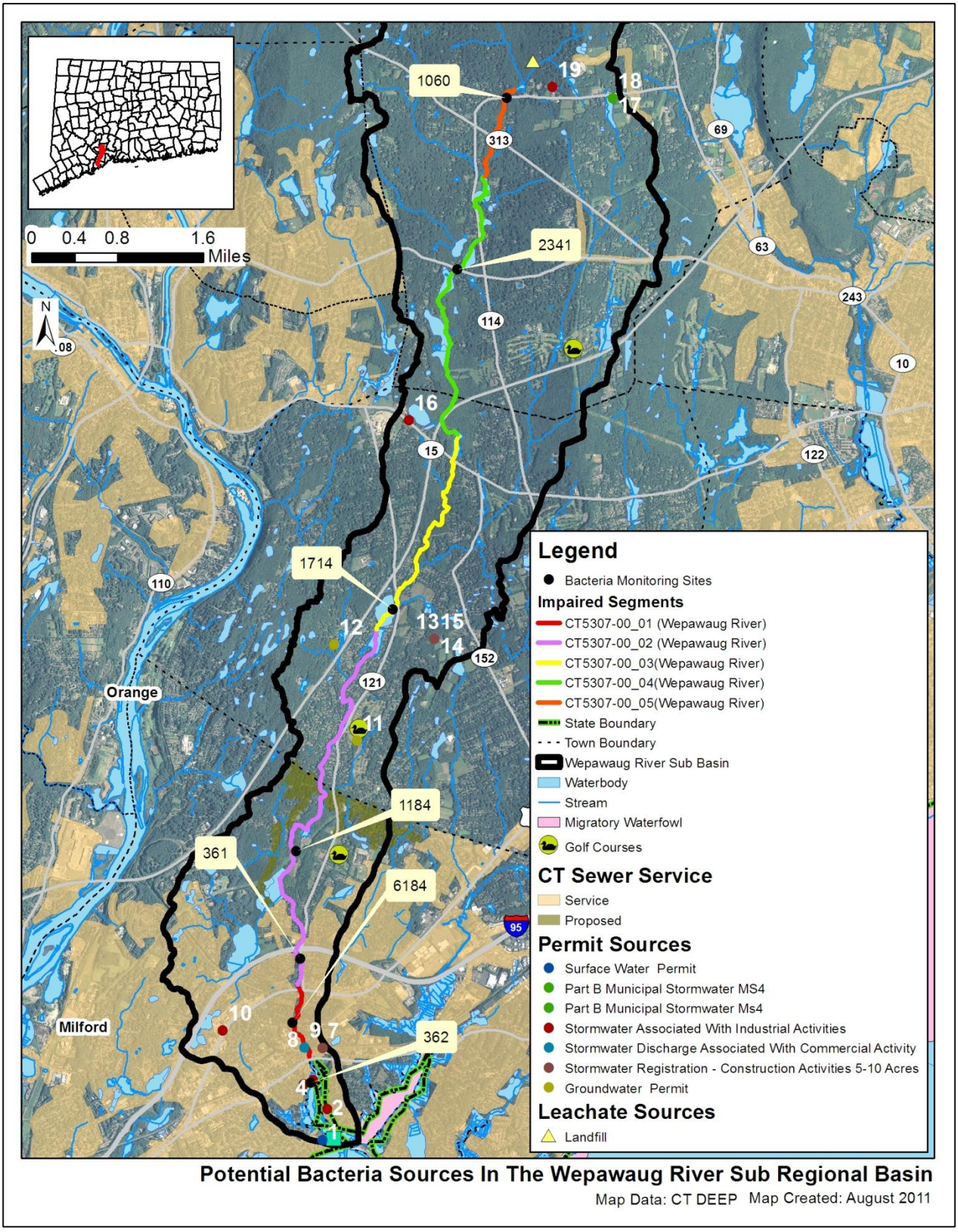
POTENTIAL BACTERIA SOURCES

Potential sources of indicator bacteria in a watershed include point and non-point sources, such as stormwater runoff, agriculture, sanitary sewer overflows (collection system failures), illicit discharges, and inappropriate discharges to the waterbody. Potential sources that have been tentatively identified in the Wepawaug River watershed based on land use (Figures 3 and 4) and a collection of local information for the impaired waterbody is presented in Table 3 and Figure 6. However, the list of potential sources is general in nature and should not be considered comprehensive. There may be other sources not listed here that contribute to the observed water quality impairment in the study segment. Further monitoring and investigation will confirm listed sources and discover additional ones. Some segments are currently listed as unassessed by CT DEEP procedures. This does not suggest that there are no potential issues on these segments, but indicates a lack of current data to evaluate the segments as part of the assessment process. For some segments, there are data from permitted sources and CT DEEP recommends that any elevated concentrations found from those permitted sources be addressed through voluntary reduction measures. More detailed evaluation of potential sources is expected to become available as activities are conducted to implement these TMDLs.

Table 3: Potential bacteria sources in the Wepawaug River watershed

Impaired Segment	Permit Source	Illicit Discharge	CSO/ SSO Issue	Failing Septic System	Agricultural Activity	Stormwater Runoff	Nuisance Wildlife/ Pets	Other
Wepawaug River CT5307-00_01	**x**	**x**		**x**		**x**	**x**	
Wepawaug River CT5307-00_02	**x**	**x**		**x**	**x**	**x**	**x**	
Wepawaug River CT5307-00_03	**x**			**x**	**x**	**x**	**x**	
Wepawaug River CT5307-00_04	**x**			**x**	**x**	**x**	**x**	
Wepawaug River CT5307-00_05	**x**			**x**	**x**	**x**	**x**	

Figure 6: Potential sources in the Wepawaug River watershed



The potential sources map for the impaired basin was developed after thorough analysis of available data sets. If information is not displayed in the map, then no sources were discovered during the analysis. The following is the list of potential sources that were evaluated: problems with migratory waterfowl, golf course locations, reservoirs, proposed and existing sewer service, cattle farms, poultry farms, permitted sources of bacteria loading (surface water discharge, MS4 permit, industrial stormwater, commercial stormwater, groundwater permits, and construction related stormwater), and leachate and discharge sources (agricultural waste, CSOs, failing septic systems, landfills, large septic tank leach fields, septage lagoons, sewage treatment plants, and water treatment or filter backwash).

Point Sources

Permitted sources within the watershed that could potentially contribute to the bacteria loading are identified in Table 4. This table includes permit types that may or may not be present in the impaired watershed. A list of active permits in the watershed is included in Table 5. Investigation and monitoring could reveal the presence of additional discharges in the watershed. Available effluent data from each of these permitted categories found within the watershed are compared to the CT State WQS for the appropriate receiving waterbody use and type. When available, bacteria data results from these permitted sources are listed in Table 6.

Table 4: General categories list of other permitted discharges

Permit Code	Permit Description Type	Number in watershed
CT	Surface Water Discharges	1
GPL	Discharge of Swimming Pool Wastewater	0
GSC	Stormwater Discharge Associated with Commercial Activity	1
GSI	Stormwater Associated with Industrial Activity	7
GSM	Part B Municipal Stormwater MS4	3
GSN	Stormwater Registration – Construction	2
LF	Groundwater Permit (Landfill)	0
UI	Underground Injection	2

Permitted Sources

As shown in Table 5, there are multiple permitted discharges in the Wepawaug River watershed. Bacteria data from 2001-2003 from several of these industrial permitted facilities are included in Table 6. Although this data cannot be compared to a water quality standard as there is no recreation standard for fecal coliform, multiple samples were high with readings over 1,000 colonies/100 mL, particularly at Milford Harbor Marina (GSI001048) and Milford Boat Works (GSI001097). Both of these discharges are downstream of the impaired segments of the Wepawaug River. While not impacting the impaired segments directly, these results reveal how other permitted sources near the impaired segments may be a potential source of bacterial contamination to the Wepawaug River.

Since the MS4 permits are not targeted to a specific location, but the geographic area of the regulated municipality, there is no one accurate location on the map to display the location of these permits. One dot will be displayed at the geographic center of the municipality as a reference point. Sometimes this

location falls outside of the targeted watershed and therefore the MS4 permit will not be displayed in the Potential Sources Map. Using the municipal border as a guideline will show which areas of an affected watershed are covered by an MS4 permit.

Table 5: Permitted facilities within the Wepawaug River watershed

Town	Client	Permit ID	Permit Type	Site Name/Address	Map #
Milford	City Of Milford	GSM000037	Part B Municipal Stormwater MS4	Milford, City Of	N/A(6)
Milford	Nancy Bodick	GSI001048	Stormwater Associated With Industrial Activities	Milford Harbor Marina, Inc.	3
Milford	Milford Boat Works, Inc.	GSI001097	Stormwater Associated With Industrial Activities	1 High Street	4
Milford	Nrg Devon Operations, Inc.	GSI001376	Stormwater Associated With Industrial Activities	Devon Power, Llc	8
Milford	City Of Milford	GSI000994	Stormwater Associated With Industrial Activities	Town Of Milford Public Works	10
Milford	Joanne Allen	GSI001051	Stormwater Associated With Industrial Activities	Spencer's Marina Inc.	2
Milford	The Stop & Shop Supermarket Company Llc	GSC000052	Stormwater Discharge Associated With Commercial Activity	Stop & Shop Store #663	16
Milford	Bvs Jai Alai, Llc	GSN001871	Stormwater Registration - Construction Activities 5-10 Acres	Proposed Retail	7
Milford	U.S. Dept Commerce Noaa-Natl.Marine Fish	CT0090182	Surface Water Permit	NE Fisheries Center	1
Orange	Grassy Hill Country Club, Inc.	UI0000402	Groundwater Permit	Grassy Hill Country Club, Inc.	11
Orange	Hubbell, Inc.	UI0000116	Groundwater Permit	Hubbell Corporate Headquarters	12
Orange	Town Of Orange	GSM000036	Part B Municipal Stormwater MS4	Orange, Town Of	N/A(14)
Orange	CT DOT	GSI000052	Stormwater Associated With Industrial Activities	Orange Maintenance Facility	16
Orange	Ravenswood Construction Llc	GSN001801	Stormwater Registration - Construction Activities 5-10 Acres	Lakeside Village	15
Woodbridge	Town Of Woodbridge	GSM000043	Part B Municipal Stormwater MS4	Woodbridge, Town Of	N/A(18)
Woodbridge	Town Of Woodbridge	GSI000717	Stormwater Associated With Industrial Activities	Woodbridge Public Works Garage	19

Table 6: Industrial permits in the Wepawaug River watershed and available fecal coliform data (colonies/100 mL). The results cannot be compared to the water quality standard as there is no recreation standard for fecal coliform. (TNTC = Too Numerous to Count)

Town	Location	Permit Number	Receiving Water	Sample Location	Sample Date	Result
Milford	Milford Harbor Marina	GSI001048	Wepawaug River	MHM drain	09/13/03	4,000
Milford	Milford Harbor Marina	GSI001048	Wepawaug River	SD	12/14/01	3,200
Milford	Milford Harbor Marina	GSI001048	Wepawaug River	SD	09/26/02	TNTC
Milford	Milford Boat Works	GSI001097	Wepawaug River	132078-MBW	12/14/01	400
Milford	Milford Boat Works	GSI001097	Wepawaug River	MBW drain	09/13/03	TNTC
Milford	Milford Boat Works	GSI001097	Wepawaug River	SD-1	09/26/02	TNTC
Woodbridge	Town of Woodbridge	GS000I717	Wepawaug River	SW-1	09/14/01	220

Municipal Stormwater Permitted Sources

Per the EPA Phase II Stormwater rule all municipal storm sewer systems (MS4s) operators located within US Census Bureau Urbanized Areas (UAs) must be covered under MS4 permits regulated by the appropriate State agency. There is an EPA waiver process that municipalities can apply for to not participate in the MS4 program. In Connecticut, EPA has granted such waivers to 19 municipalities. All participating municipalities within UAs in Connecticut are currently regulated under MS4 permits by CT DEEP staff in the MS4 program.

The US Census Bureau defines a UA as a densely settled area that has a census population of at least 50,000. A UA generally consists of a geographic core of block groups or blocks that exceeds the 50,000 people threshold and has a population density of at least 1,000 people per square mile. The UA will also include adjacent block groups and blocks with at least 500 people per square mile. A UA consists of all or part of one or more incorporated places and/or census designated places, and may include additional territory outside of any place. (67 FR 11663)

For the 2000 Census a new geographic entity was created to supplement the UA blocks of land. This created a block known as an Urban Cluster (UC) and is slightly different than the UA. The definition of a UC is a densely settled area that has a census population of 2,500 to 49,999. A UC generally consists of a geographic core of block groups or blocks that have a population density of at least 1,000 people per square mile, and adjacent block groups and blocks with at least 500 people per square mile. A UC consists of all or part of one or more incorporated places and/or census designated places; such a place(s) together with adjacent territory; or territory outside of any place. The major difference is the total population cap of 49,999 people for a UC compared to >50,000 people for a UA. (67 FR 11663)

While it is possible that CT DEEP will be expanding the reach of the MS4 program to include UC municipalities in the near future they are not currently under the permit. However, the GIS layers used to

create the MS4 maps in this Statewide TMDL did include both UA and UC blocks. This factor creates some municipalities that appear to be within an MS4 program that are not currently regulated through an MS4 permit. This oversight can explain a municipality that is at least partially shaded grey in the maps and there are no active MS4 reporting materials or information included in the appropriate appendix. While these areas are not technically in the MS4 permit program, they are still considered urban by the cluster definition above and are likely to contribute similar stormwater discharges to affected waterbodies covered in this TMDL.

As previously noted, EPA can grant a waiver to a municipality to preclude their inclusion in the MS4 permit program. One reason a waiver could be granted is a municipality with a total population less than 1000 people, even if the municipality was located in a UA. There are 19 municipalities in Connecticut that have received waivers, this list is: Andover, Bozrah, Canterbury, Coventry, East Hampton, Franklin, Haddam, Killingworth, Litchfield, Lyme, New Hartford, Plainfield, Preston, Salem, Sherman, Sprague, Stafford, Washington, and Cromwell. There will be no MS4 reporting documents from these towns even if they are displayed in an MS4 area in the maps of this document.

The list of US Census UCs is defined by geographic regions and is named for those regions, not necessarily by following municipal borders. In Connecticut the list of UCs includes blocks in the following Census Bureau regions: Colchester, Danielson, Lake Pocotopaug, Plainfield, Stafford, Storrs, Torrington, Willimantic, Winsted, and the border area with Westerly, RI (67 FR 11663). Any MS4 maps showing these municipalities may show grey areas that are not currently regulated by the CT DEEP MS4 permit program.

The impaired segments of the Wepawaug River watershed are located within the City of Milford, and the Towns of Orange and Woodbridge. These municipalities are largely urbanized, as defined by the U.S. Census Bureau, and are required to comply with the General Permit for the Discharge of Stormwater from Small Municipal Storm Sewer Systems (MS4 permit) issued by the Connecticut Department of Energy and Environmental Protection (DEEP) (Figure 7). This general permit is only applicable to municipalities that are identified in Appendix A of the MS4 permit that contain designated urban areas and discharge stormwater via a separate storm sewer system to surface waters of the State. The permit requires municipalities to develop a Stormwater Management Plan (SMP) to reduce the discharge of pollutants and protect water quality. The MS4 permit is discussed further in the "TMDL Implementation Guidance" section of the core TMDL document. Additional information regarding stormwater management and the MS4 permit can be obtained on CTDEEP's website (http://www.ct.gov/dep/cwp/view.asp?a=2721&q=325702&depNav_GID=1654).

Multiple MS4 outfalls have been sampled for *E. coli* bacteria in the watershed from 2005-2010 (Table 7). One outfall was sampled in each municipality (Milford, Orange, and Woodbridge) and all outfalls exceeded the single sample WQS of 410 colonies/100 mL for *E. coli* on multiple sampling dates.

Figure 7: MS4 areas of the Wepawaug River watershed

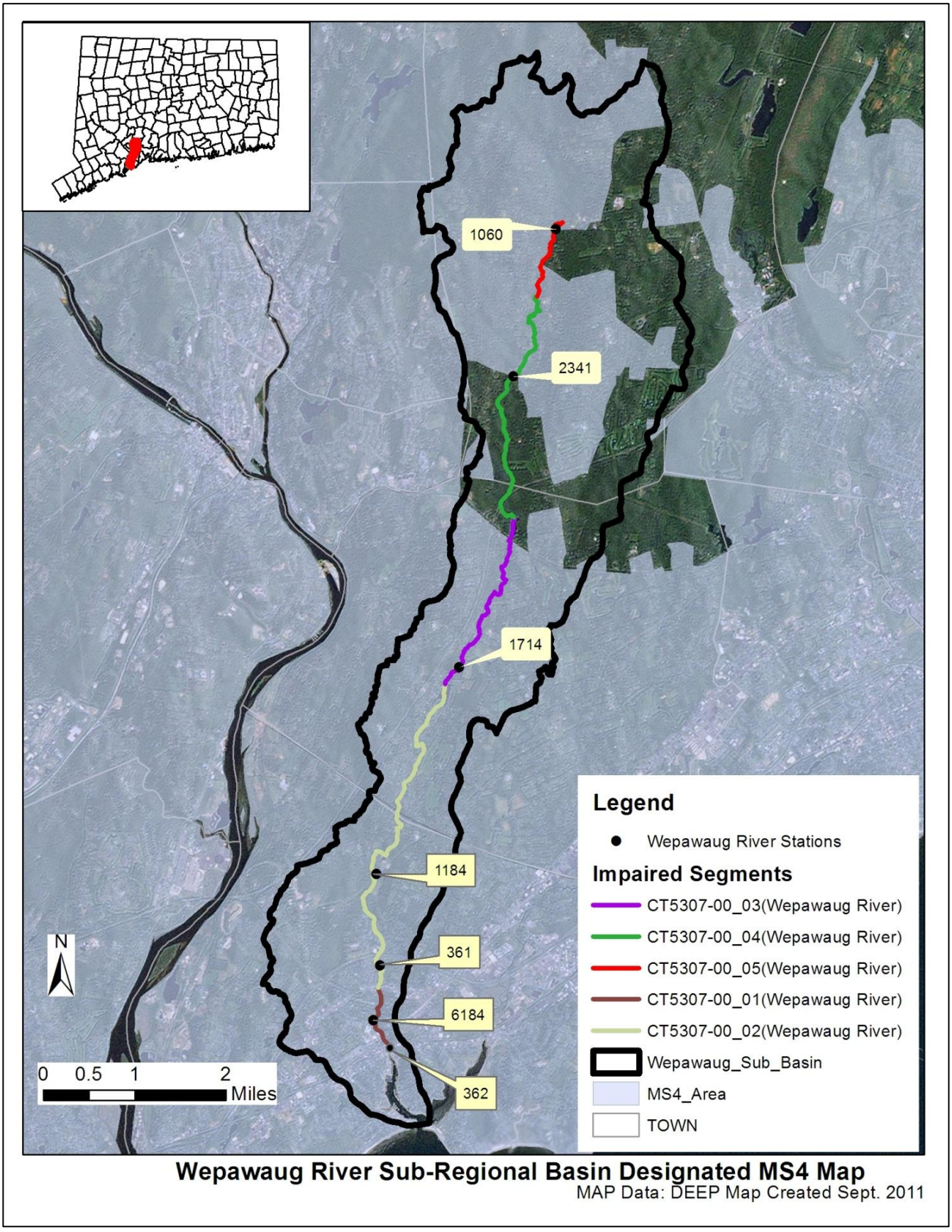


Table 7: MS4 permits in the Wepawaug River watershed with *E. coli* (colonies/100 mL) sample results

Town	Location	MS4 Type	Receiving Waters	Sample Date	Result
Milford	Factory Lane	Commercial	Wepawaug River	11/30/05	TNTC
Milford	Factory Lane	Commercial	Wepawaug River	09/11/07	TNTC
Milford	Factory Lane	Commercial	Wepawaug River	11/13/08	1,900
Milford	Factory Lane	Commercial	Wepawaug River	10/15/09	>2500
Milford	Factory Lane	Commercial	Wepawaug River	11/04/10	>2000
Orange	East side of Mapledale Rd D70-6	Residential	Wepawaug River	12/29/05	220
Orange	East side of Mapledale Rd D70-6	Residential	Wepawaug River	02/03/06	93
Orange	East side of Mapledale Rd D70-6	Residential	Wepawaug River	11/08/06	35
Orange	East side of Mapledale Rd D70-6	Residential	Wepawaug River	09/11/07	1,986
Orange	East side of Mapledale Rd D70-6	Residential	Wepawaug River	11/25/08	219
Orange	East side of Mapledale Rd D70-6	Residential	Wepawaug River	10/07/09	>2419.6
Orange	East side of Mapledale Rd D70-6	Residential	Wepawaug River	10/15/10	179
Woodbridge	Pine Ridge Rd, Cul-de-sac SE pipe SW-A	Residential	Wepawaug River	11/12/04	>8000
Woodbridge	Pine Ridge Rd, Cul-de-sac SE pipe SW-A	Residential	Wepawaug River	11/09/05	34
Woodbridge	Pine Ridge Rd, Cul-de-sac SE pipe SW-A	Residential	Wepawaug River	11/08/06	161
Woodbridge	Pine Ridge Rd, Cul-de-sac SE pipe SW-A	Residential	Wepawaug River	01/11/08	261
Woodbridge	Pine Ridge Rd, Cul-de-sac SE pipe SW-A	Residential	Wepawaug River	11/06/08	387
Woodbridge	Pine Ridge Rd, Cul-de-sac SE pipe SW-A	Residential	Wepawaug River	09/11/09	1,986
Woodbridge	Pine Ridge Rd, Cul-de-sac SE pipe SW-A	Residential	Wepawaug River	10/15/10	2,420

Shaded cells indicate an exceedance of single-sample based water quality criteria (410 colonies/100 mL)
TNTC = Too numerous to count

Non-point Sources

Non-point source pollution (NPS) comes from many diffuse sources and is more difficult to identify and control. NPS pollution is often associated with land-use practices. Examples of NPS that can contribute bacteria to surface waters include insufficient septic systems, pet and wildlife waste, agriculture, and contact recreation (swimming or wading). Potential sources of NPS within the Wepawaug River watershed are described below.

Wildlife and Domestic Animal Waste

Wildlife and domestic animals within the Wepawaug River watershed represent a potential source of bacteria. With the construction of roads and drainage systems, these wastes may no longer be retained on the landscape, but instead may be conveyed via stormwater to the nearest surface water. These physical land alterations can exacerbate the impact of natural sources on water quality (USEPA, 2001).

Geese and other waterfowl are known to congregate in open areas including recreational fields, agricultural crop fields, and golf courses. Two golf courses, the Grassy Hill Country Club along Route 121 in Orange and Orchards Golf Course on Kozlowski Road in Milford, are located in close proximity to

Wepawaug River (Segment 2). There is also a large grassed area near the intersection of North Street and Bridge Street in Milford along Wepawaug River (Segment 1). There is no buffer along the river in this section, which provides waterfowl easy access to Wepawaug River (Segment 1). The Tradition Golf Club at Oak Lane is located off Racebrook Road in Woodbridge near Wepawaug River (Segment 4). In addition to creating a nuisance, large numbers of geese can also create unsanitary conditions on the grassed areas and cause water quality problems due to bacterial contamination associated with their droppings. Large populations of geese can also lead to habitat destruction as a result of overgrazing on wetland and riparian plants.

Dense residential development surrounds much of Wepawaug River (Segment 2) in Orange and Milford and Wepawaug River (Segment 1) in Milford (Figure 5). When not properly disposed, waste from domestic animals such as dogs and horses can enter surface waters directly or through stormwater infrastructure. The Eisenhower Dog Park is located along Wepawaug River (Segment 2) off W. River Street in Milford. Area residents frequent this park with their dogs and horses. Therefore, pet waste and horse manure along trails near the Wepawaug River may also be contributing to bacteria concentrations in the impaired segments of the Wepawaug River (Eisenhower, 2010).

Stormwater Runoff from Developed Areas

Approximately 49% of the watershed is considered urban, and much of that area is concentrated around the impaired segments in the Towns of Woodbridge and Orange, and the City of Milford (Figures 4 and 9). Urban areas are often characterized by impervious cover, or surface areas such as roofs and roads that force water to run off land surfaces rather than infiltrate the soil. Studies have shown a link between increasing impervious cover and degrading water quality conditions in a watershed (CWP, 2003). In one study, researchers correlated the amount of fecal coliform to the percent of impervious cover in a watershed (Mallin *et al*., 2000).

Approximately 23% of the Wepawaug River watershed is characterized by 0-6% impervious cover, particularly near Wepawaug River (Segment 4), 34% is characterized by 7-11% impervious cover near Segment 5, 26% is characterized by 12-15% impervious cover, near Segments 2 and 3, and 17% is characterized by greater than 16% impervious cover, near Segments 1 and 2 (Figures 8 and 9). Water quality data taken at all stations on the impaired segments were consistently high, especially during wet-weather, which suggests that stormwater runoff may be a source of bacteria to the Wepawaug River watershed (Tables 12-16).

Figure 8: Range of impervious cover (%) in the Wepawaug River watershed

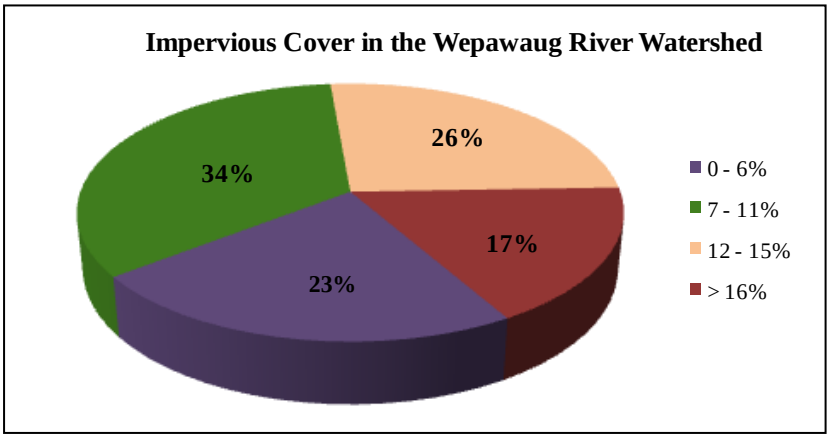
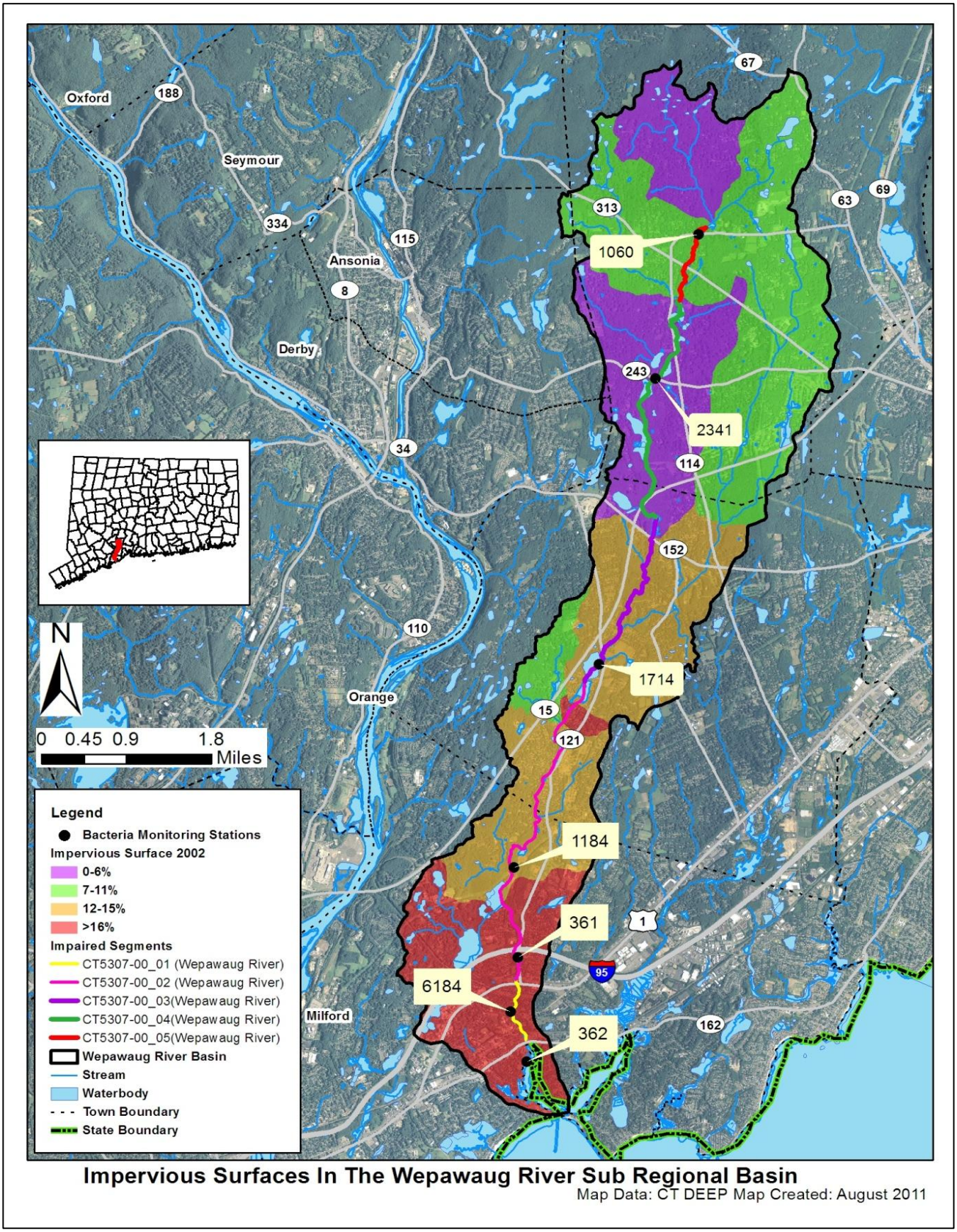


Figure 9: Impervious cover (%) for the Wepawaug River sub-regional watershed



Insufficient Septic Systems and Illicit Discharges

As shown in Figure 6, the majority of residents in the Wepawaug River watershed, particularly upstream of Wepawaug River (Segment 2), do not have access to a sanitary sewer and instead rely on onsite wastewater treatment systems, such as septic systems. Insufficient or failing septic systems can be significant sources of bacteria by allowing raw waste to reach surface waters. In Connecticut, local health directors or health districts are responsible for keeping track of any reported insufficient or failing septic systems in a specific municipality. The City of Milford also has its own Health Department (http://www.ci.milford.ct.us/public_documents/milfordct_health/Health). The Town of Orange also has its own Health Department with a full-time health director (http://www.orange-ct.gov/govser/healthdep.htm). The Town of Woodbridge is part of the regional Quinnipiack Valley Health District (http://www.qvhd.org).

The majority of the area surrounding the Wepawaug River (Segments 1 and 2) are serviced by sanitary sewer. Proposed sewer lines were also identified in Figure 6 near the Milford-Orange border along Wepawaug River (Segment 2). Sewer system leaks and other illicit discharges located within the watershed, particularly near Wepawaug River (Segments 1 and 2), may be contributing bacteria to these waterbodies. Water quality data taken at Station 6184 on Wepawaug River (Segment 1) and Station 361 on Wepawaug River (Segment 2) were consistently high, especially during dry-weather, which suggests that leaks from sewer pipes may be a source of bacteria to the Wepawaug River watershed (Tables 12 and 13). In particular, dry-weather values at both stations were greater than wet-weather values.

Agricultural Activities

Agricultural operations are an important economic activity and landscape feature in many areas of the State. Runoff from agricultural fields may contain pollutants such as bacteria and nutrients (USEPA, 2011a). This runoff can include pollutants from farm practices such as storing manure, allowing livestock to wade in nearby waterbodies, applying fertilizer, and reducing the width of vegetated buffer along the shoreline. Agricultural land use makes up 3% of the Wepawaug River watershed. There are several agricultural operations along Wepawaug River (Segment 2) in Orange and Milford, along Old Grassy Hill Road in Orange at Wrights Pond near Wepawaug River (Segment 3), along Baldwin Road in Woodbridge near Wepawaug River (Segment 4), and along Beecher Road in Woodbridge near Wepawaug River (Segment 5). Wrights Pond outlets to a small tributary stream that enters the upstream portion of Wepawaug River (Segment 2) at Lake Wepawaug. These operations may carry pollutants, including bacteria, to the impaired segments.

Additional Sources

A landfill was identified in Figure 6 upstream of Wepawaug River (Segment 5). There may be other sources not listed here or identified in Figure 6 that contribute to the observed water quality impairment in the Wepawaug River watershed. Further monitoring and investigation will confirm the listed sources and discover additional ones. More detailed evaluation of potential sources is expected to become available as activities are conducted to implement this TMDL.

Land Use/Landscape

Riparian Buffer Zones

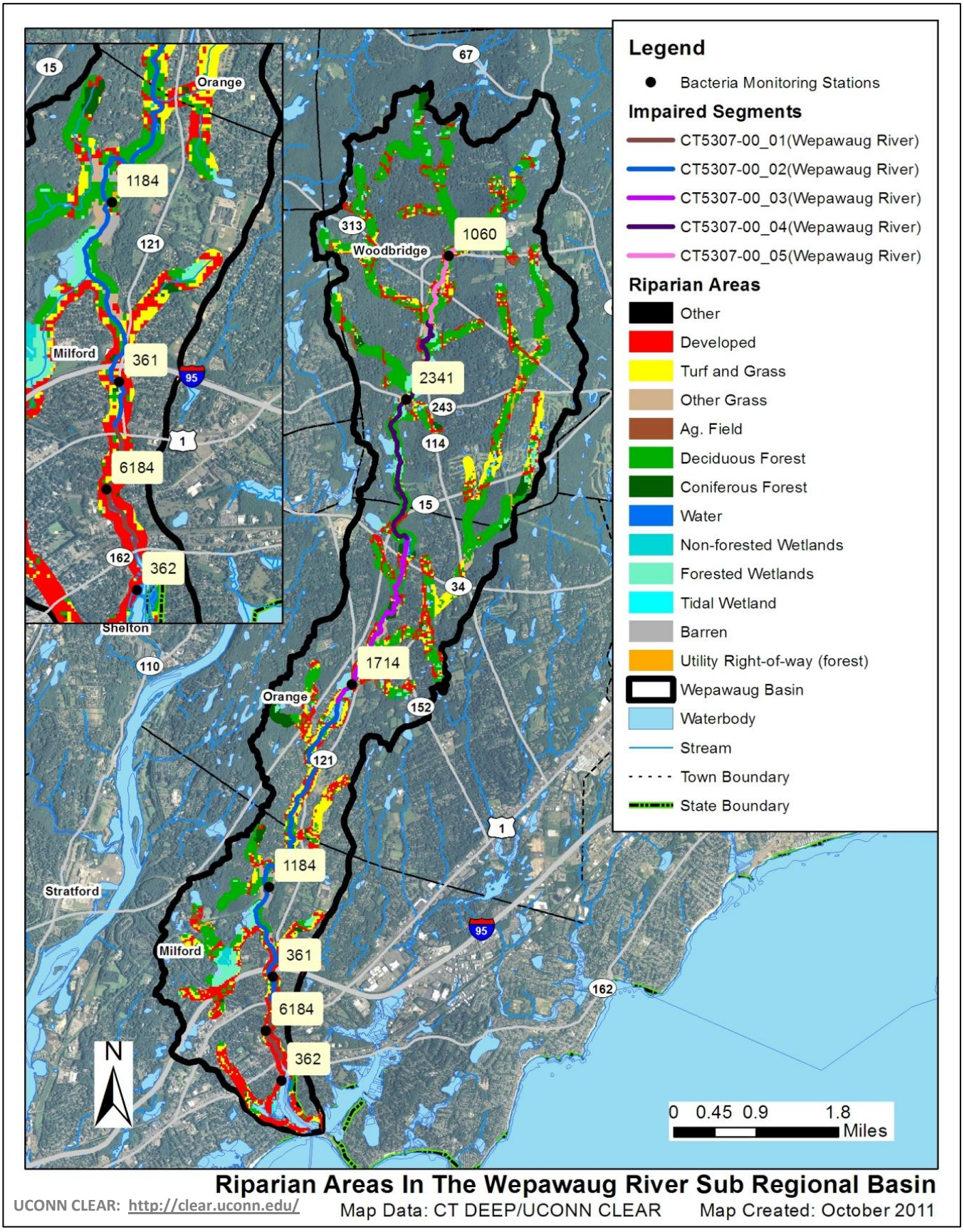
The riparian buffer zone is the area of land located immediately adjacent to streams, lakes, or other surface waters. The boundary of the riparian zone and the adjoining uplands is gradual and not always

well-defined. However, riparian zones differ from uplands because of high levels of soil moisture, frequent flooding, and the unique assemblage of plant and animal communities found there. Through the interaction of their soils, hydrology, and vegetation, natural riparian areas influence water quality as contaminants are taken up into plant tissues, adsorbed onto soil particles, or modified by soil organisms. Any change to the natural riparian buffer zone can reduce the effectiveness of the natural buffer and has the potential to contribute to water quality impairment (USEPA, 2011b).

The CLEAR program at UCONN has created streamside buffer layers for the entire State of Connecticut (http://clear.uconn.edu/), which have been used in this TMDL. Analyzing this information can reveal potential sources and implementation opportunities at a localized level. The land use directly adjacent to a waterbody can have direct impacts on water quality from surface runoff sources.

The riparian zone of the majority of Wepawaug River (Segment 1), the downstream portion of Wepawaug River (Segment 2), and portions of Wepawaug River (Segments 3 and 5) are characterized by developed land use (Figure 10). Most of the riparian zone for Wepawaug River (Segments 2-5) is characterized by turf grass and forested land use. Developed areas within the riparian zone likely contribute pollutants such as bacteria to the waterbody since the natural riparian buffer cannot treat stormwater runoff from impervious surfaces.

Figure 10: Riparian buffer zone information for the Wepawaug River watershed



CURRENT MANAGEMENT ACTIVITIES

The Towns of Woodbridge and Orange and the City of Milford have developed and implemented some programs to protect water quality from bacterial contamination. The City of Milford has taken action to restore Eisenhower Park. Land Tech Consultants completed a Natural Resource Inventory (NRI) for Eisenhower Park in 2005, and King's Mark Environmental Review Team (ERT) completed a report on its revitalization (Eisenhower, 2010). The reports address water quality issues in the Wepawaug River, and offer recommendations for BMP installation at areas that may be contributing bacteria.

As indicated previously, the watershed communities are regulated under the MS4 program. The MS4 General Permit is required for any municipality with urbanized areas that initiates, creates, originates or maintains any discharge of stormwater from a storm sewer system to waters of the State. The MS4 permit requires towns to design a Stormwater Management Plan (SMP) that reduces the discharge of pollutants in stormwater and improves water quality. The plan must address the following 6 minimum measures:

1. Public Education and Outreach.
2. Public Involvement/Participation.
3. Illicit discharge detection and elimination.
4. Construction site stormwater runoff control.
5. Post-construction stormwater management.
6. Pollution prevention/good housekeeping.

Each municipality is also required to submit an annual update outlining steps taken to meet the six minimum measures. All updates that address bacterial contamination in the watershed are summarized in Tables 8, 9, and 10.

Table 8: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Milford, CT (Permit # GSM000030)

Minimum Measure	Milford 2010 Annual Report Update
Public Outreach and Education	1) Local newspapers published articles and letters to the editor regarding the affect of stormwater pollution in Long Island Sound, and measures that citizens can take to prevent stormwater pollution.
Public Involvement and Participation	1) The Inland Wetlands Agency (IWA) is collaborating with the Southwest Conservation District on a lower Wepawaug River Watershed Study. The goal is to propose a restoration project.
	2) The DPW supported volunteers on multiple clean ups throughout the City focusing on river side and ocean side parks.
Illicit Discharge Detection and Elimination	1) The City approved 3 permits for connections to the City's stormwater drainage system. Applicants who received a connection to the system signed an agreement with the City that stated only "clear and uncontaminated water" will be discharged to the system.

Table 8: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Milford, CT (Permit # GSM000030) (continued)

Minimum Measure	Milford 2010 Annual Report Update
Construction Site Stormwater Runoff Control	1) The IWA issued 6 violations for construction activities, and enforcement actions were taken when necessary. All items and concerns were addressed by site contractors or developers.
	2) Members of the IWA continued to attend trainings, workshops, seminars, and courses in 2010.
Post Construction Stormwater management	1) A variety of stormwater control structures were installed in 2010. The IWA requires that a maintenance manual be maintained on site for all facilities installed at commercial sites.
Pollution Prevention and Good Housekeeping	1) In 2010, 121 catch basins were inspected and cleaned (if necessary). Approximately 700 cubic yards of material were removed from these catch basins.

Table 9: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Orange, CT (Permit # GSM000036)

Minimum Measure	Orange 2010 Annual Report Update
Public Outreach and Education	No updates.
Public Involvement and Participation	No updates.
Illicit Discharge Detection and Elimination	1) The Town continued monitoring for IDDE. All 170 outfalls in Orange were inspected by the DPW. No outfalls were observed to have odors or discolorations caused by illicit discharges.
Construction Site Stormwater Runoff Control	No updates.
Post Construction Stormwater management	No updates.
Pollution Prevention and Good Housekeeping	No updates.

Table 10: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Woodbridge, CT (Permit # GSM000043)

Minimum Measure	Town of Woodbridge 2010 Annual Report
Public Outreach and Education	1) Developed and distributed educational brochure.
	2) Developed and distributed educational video.
	3) Developing a program to provide workshops to public.
Public Involvement and Participation	1) Developed stormwater committee and implemented regular meetings.
Illicit Discharge Detection and Elimination	1) Updated mapping of town drainage system on GIS system.
	2) Developed a program to address elimination of illicit discharges.
	3) Developed illicit discharge and stormwater ordinances that have been approved and adopted.

Table 10: Summary of MS4 requirement updates related to the reduction of bacterial contamination from Woodbridge, CT (Permit # GSM000043) (continued)

Minimum Measure	Town of Woodbridge 2010 Annual Report
Construction Site Stormwater Runoff Control	1) Continually updating Town Zoning Regulations pertaining to stormwater management.
Post Construction Stormwater Management	1) Developing a program to ensure the review of BMPs for all construction activities greater than one acre.
Pollution Prevention and Good Housekeeping	1) Developed program of inspection and enforcement of E&S and stormwater control measures.
	2) Training program has been developed and implemented.
	3) Continued cleaning of catch basins and street sweeping.

RECOMMENDED NEXT STEPS

The Towns of Orange and Woodbridge and the City of Milford have developed and implemented programs to protect water quality from bacterial contamination. Future mitigative activities are necessary to ensure the long-term protection of the Wepawaug River and have been prioritized below.

1) Evaluate the municipal education and outreach programs regarding animal waste.

Any education and outreach programs should highlight the importance of not feeding waterfowl and wildlife, and picking up after dogs and other pets within recreational areas along the Wepawaug River. The Eisenhower Park Revitalization Report discusses potential water quality issues associated with dogs, horses, and geese within Eisenhower Park in Milford surrounding Wepawaug River (Segment 2) (Eisenhower, 2010). Since residents often walk their dogs and ride horses within the park near Wepawaug River (Segment 2), pet waste may be contributing bacteria to the waterbody. The report recommends that residents pick up after their dogs or horses within the park, and park managers establish a riparian buffer along Wepawaug River (Segment 2) to protect the waterbody from bacterial contamination and make the shoreline less attractive to geese or other waterfowl (Eisenhower, 2010).

Municipalities and residents can take measures to minimize waterfowl-related impacts such as allowing tall, coarse vegetation to grow in the riparian areas of the Wepawaug River that are frequented by waterfowl. Waterfowl, especially grazers like geese, prefer easy access to water. Maintaining an uncut vegetated buffer along the shore will make the habitat less desirable to geese and encourage migration. In addition, any educational program should emphasize that feeding waterfowl, such as ducks, geese, and swans, may contribute to water quality impairments in the Wepawaug River watershed and can harm human health and the environment. Animal wastes should be disposed of away from any waterbody or storm drain system. BMPs effective at reducing the impact of animal waste on water quality include installing signage, providing pet waste receptacles in high-use areas, enacting ordinances requiring the clean-up of pet waste, and targeting educational and outreach programs in problem areas.

2) Identify areas along developed portions of the Wepawaug River to implement Best Management Practices (BMPs) to control stormwater runoff.

As noted previously, approximately 49% of the Wepawaug River watershed is considered urban, and high impervious surface percentages were identified around Wepawaug River (Segments 1-3). As such, stormwater runoff may be contributing bacteria to these segments. To identify areas that are contributing bacteria to the impaired segments, the towns should continue to conduct wet-weather sampling and prioritize sampling stations with high bacteria concentrations for BMP installation (Table 6). To treat stormwater runoff, the towns should identify areas along the impaired segments to install BMPs that encourage stormwater to infiltrate the ground before entering the waterbodies. These BMPs would disconnect impervious areas and reduce pollutant loads to the river. More detailed information and BMP recommendations can be found in the core TMDL document.

3) Implement a program to evaluate the sanitary sewer system.

The majority of residents around Wepawaug River (Segments 1 and 2) rely on a municipal sewer system (Figure 6). It is important for municipalities to develop a program to evaluate their sanitary sewer and reduce leaks and overflows. This program should include periodic inspections of the sewer line.

4) Develop a system to monitor septic systems.

Residents upstream of Wepawaug River (Segment 2) rely on septic systems. If not already in place, the towns should establish a program to ensure that existing septic systems are properly operated and maintained. For instance, communities can create an inventory of existing septic systems through mandatory inspections. Inspections help encourage proper maintenance and identify failed and sub-standard systems. Policies that govern the eventual replacement of the sub-standard systems within a reasonable timeframe could be adopted. Towns can also develop programs to assist citizens with the replacement and repair of older and failing systems.

5) Ensure there are sufficient buffers on agricultural lands along the Wepawaug River.

Agricultural land use represents 3% of the Wepawaug River watershed. If not already in place, agricultural producers should work with the CT Department of Agriculture and the U.S. Department of Agriculture Natural Resources Conservation Service to develop conservation plans for their farming activities within the watershed. These plans should focus on ensuring that there are sufficient stream buffers, that fencing exists to restrict access to livestock and horses from streams and wetlands, and that animal waste handling, disposal, and other appropriate BMPs are in place. Particular attention should be paid to agricultural operations near the impaired segments and Wrights Pond.

6) Continue monitoring of permitted sources.

Previous sampling of discharges from permitted sources in Milford show elevated levels of fecal coliform bacteria, an indicator of bacterial pollution (Table 6). Sampling from MS4 discharges in Milford, Orange, and Woodbridge have also shown elevated levels of bacteria (Table 7). Further monitoring will provide information essential to better locate, understand, and reduce pollution sources. If any current monitoring is not done with appropriate bacterial indicator based on the receiving water, then a recommended change during the next permit reissuance is to include the appropriate indicator species. If facility monitoring indicates elevated bacteria, then implementation of permit required, and voluntary measures to identify and reduce sources of bacterial contamination at the facility are an additional recommendation. Regular monitoring should be established for all permitted sources to ensure compliance with permit requirements and to determine if current requirements are adequate or if additional measures are necessary for water quality protection. The following table details the appropriate bacteria criteria for use as permit limits for permittees as permits are renewed and updated, within the Wepawaug River Watershed.

Section 6(k) of the MS4 General Permit requires a municipality to modify their Stormwater Management Plan to implement the TMDL within four months of TMDL approval by EPA if stormwater within the municipality contributes pollutant(s) in excess of the allocation established by the TMDL. For discharges to impaired waterbodies, the municipality must assess and modify the six minimum measures of its plan, if necessary, to meet TMDL standards. Particular focus should be placed on the following plan components: public education, illicit discharge detection and elimination, stormwater structures cleaning, and the repair, upgrade, or retrofit of storm sewer structures. The goal of these modifications is to establish a program that improves water quality consistent with TMDL requirements. Modifications to the Stormwater Management Plan in response to TMDL development should be submitted to the Stormwater Program of DEEP for review and approval.

Table 11 details the appropriate bacteria criteria for use as waste load allocations established by this TMDL for use as water quality targets by permittees as permits are renewed and updated, within the Wepawaug watershed.

For any municipality subject to an MS4 permit and affected by a TMDL, the permit requires a modification of the SMP to include BMPs that address the included impairment. In the case of bacteria related impairments municipal BMPs could include: implementation or improvement to existing nuisance wildlife programs, septic system monitoring programs, any additional measures that can be added to the required illicit discharge detection and elimination (IDDE) programs, and increased street sweeping above basic permit requirements. Any non-MS4 municipalities can implement these same types of initiatives in effort to reduce bacteria source loading to impaired waterways.

Any facilities that discharge non-MS4 regulated stormwater should update their Pollution Prevention Plan to reflect BMPs that can reduce bacteria loading to the receiving waterway. These BMPs could include nuisance wildlife control programs and any installations that increase surface infiltration to reduce overall stormwater volumes. Facilities that are regulated under the Commercial Activities Stormwater Permit should report any updates to their SMP in their summary documentation submitted to DEEP.

Table 11. Bacteria (e.coli) TMDLs, WLAs, and LAs for Recreational Use

		Instantaneous *E. coli* (#/100mL)						Geometric Mean *E. coli* (#/100mL)	
Class	**Bacteria Source**	**WLA[6]**			**LA[6]**			**WLA[6]**	**LA[6]**
	Recreational Use	**1**	**2**	**3**	**1**	**2**	**3**	**All**	**All**
AA	Illicit sewer connection	0	0	0				0	
	Leaking sewer lines	0	0	0				0	
	Stormwater (MS4s)	235[7]	410[7]	576[7]				126[7]	
	Stormwater (non-MS4)				235[7]	410[7]	576[7]		126[7]
	Wildlife direct discharge				235[7]	410[7]	576[7]		126[7]
	Human or domestic animal direct discharge[5]				235	410	576		126
A	Non-Stormwater NPDES	0	0	0				0	
	CSOs	0	0	0				0	
	SSOs	0	0	0				0	
	Illicit sewer connection	0	0	0				0	
	Leaking sewer lines	0	0	0				0	
	Stormwater (MS4s)	235[7]	410[7]	576[7]				126[7]	
	Stormwater (non-MS4)				235[7]	410[7]	576[7]		126[7]
	Wildlife direct discharge				235[7]	410[7]	576[7]		126[7]
	Human or domestic animal direct discharge[5]				235	410	576		126

(1) **Designated Swimming.** Procedures for monitoring and closure of bathing areas by State and Local Health Authorities are specified in: Guidelines for Monitoring Bathing Waters and Closure Protocol, adopted jointly by the Department of Environmental Protections and the Department of Public Health. May 1989. Revised April 2003 and updated December 2008.

(2) **Non-Designated Swimming.** Includes areas otherwise suitable for swimming but which have not been designated by State or Local authorities as bathing areas, waters which support tubing, water skiing, or other recreational activities where full body contact is likely.

(3) **All Other Recreational Uses.**

(4) Criteria for the protection of recreational uses in Class B waters do not apply when disinfection of sewage treatment plant effluents is not required consistent with Standard 23. (Class B surface waters located north of Interstate Highway I-95 and downstream of a sewage treatment plant providing seasonal disinfection May 1 through October 1, as authorized by the Commissioner.)

(5) Human direct discharge = swimmers

(6) Unless otherwise required by statute or regulation, compliance with this TMDL will be based on ambient concentrations and not end-of-pipe bacteria concentrations

(7) Replace numeric value with "natural levels" if only source is naturally occurring wildlife. Natural is defined as the biological, chemical and physical conditions and communities that occur within the environment which are unaffected or minimally affected by human influences (CT DEEP 2011a). Sections 2.2.2 and 6.2.7 of this Core Document deal with BMPs and delineating type of wildlife inputs.

BACTERIA DATA AND PERCENT REDUCTIONS TO MEET THE TMDL

Table 12: Wepawaug River (Segment 1) Bacteria Data

Waterbody ID: CT5307-00_01

Characteristics: Freshwater, Class A, Potential Drinking Water Source, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 410 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **73%**

Single Sample: **97%**

Data: 1998 and 2010 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Wepawaug River (Segment 1) with annual geometric means

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
362	Upstream of Route 162 crossing	9/28/1998	3100	dry	NA
6184	#100 West River Road	8/26/2010	330	wet	**465* (73%)**
6184	#100 West River Road	9/9/2010	98	dry	
6184	#100 West River Road	9/14/2010	120	dry	
6184	#100 West River Road	9/20/2010	410	dry	
6184	#100 West River Road	9/22/2010	**16000* (97%)**	dry	
6184	#100 West River Road	9/27/2010	430	wet	
6184	#100 West River Road	9/29/2010	430	dry	

Shaded cells indicate an exceedance of water quality criteria

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather *E. coli* (colonies/100 mL) geometric mean values for all monitoring stations on Wepawaug River (Segment 1)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
362	Upstream of Route 162 crossing	1998	0	1	NA	NA	NA
6184	#100 West River Road	2010	2	5	465	377	506

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gage at Tweed KMMK station in New Haven, CT

Table 13: Wepawaug River (Segment 2) Bacteria Data

Waterbody ID: CT5307-00_02

Characteristics: Freshwater, Class A, Potential Drinking Water Source, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 410 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **88%**

Single Sample: **74%**

Data: 1998, 2003, and 2010 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Wepawaug River (Segment 2) with annual geometric means calculated

Station Name	Station Location	Date	Results	Wet/Dry	Geomean
361	Downstream of Walnut Street crossing	7/23/1998	720	dry	**1073* (88%)**
361	Downstream of Walnut Street crossing	9/28/1998	**1600* (74%)**	dry	
361	Downstream of Walnut Street crossing	8/11/2010	250	dry	349
361	Downstream of Walnut Street crossing	8/26/2010	440	wet	
361	Downstream of Walnut Street crossing	9/9/2010	180	dry	
361	Downstream of Walnut Street crossing	9/14/2010	490	dry	
361	Downstream of Walnut Street crossing	9/20/2010	760	dry	
361	Downstream of Walnut Street crossing	9/22/2010	240	dry	
361	Downstream of Walnut Street crossing	9/27/2010	190	wet	
361	Downstream of Walnut Street crossing	9/29/2010	650	dry	
1184	Eisenhower Park	10/29/2003	1100	wet	NA

Shaded cells indicate an exceedance of water quality criteria

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather *E. coli* (colonies/100 mL) geometric mean values for all monitoring stations on Wepawaug River (Segment 2)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
361	Downstream of Walnut Street crossing	1998, 2010	2	8	437	289	484
1184	Eisenhower Park	2003	1	0	NA	NA	NA
Shaded cells indicate an exceedance of water quality criteria							
Weather condition determined from rain gage at Tweed KMMK station in New Haven, CT							

Table 14: Wepawaug River (Segment 3) Bacteria Data

Waterbody ID: CT5307-00_03

Characteristics: Freshwater, Class A, Potential Drinking Water Source, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 410 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **68%**

Single Sample: **90%**

Data: 2010-2011 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Wepawaug River (Segment 3) with annual geometric means calculated

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1714	Downstream of Route 121	8/11/2010	**4100* (90%)**	dry	267
1714	Downstream of Route 121	8/26/2010	230	wet	
1714	Downstream of Route 121	9/9/2010	170	dry	
1714	Downstream of Route 121	9/14/2010	160	dry	
1714	Downstream of Route 121	9/20/2010	190	dry	
1714	Downstream of Route 121	9/22/2010	170	dry	
1714	Downstream of Route 121	9/27/2010	63	wet	
1714	Downstream of Route 121	9/29/2010	490	dry	
1714	Downstream of Route 121	5/16/2011	280	dry	**389* (68%)**
1714	Downstream of Route 121	6/14/2011	540	wet	

Shaded cells indicate an exceedance of water quality criteria

†Average of two duplicate samples

**** Weather conditions for selected data taken from Hartford because local station had missing data**

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather *E. coli* (colonies/100 mL) geometric mean values for all monitoring stations on Wepawaug River (Segment 3)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
1714	Downstream of Route 121	2010-2011	3	7	288	199	337
Shaded cells indicate an exceedance of water quality criteria							
Weather condition determined from rain gages at Tweed_New Haven_KHVN in New Haven, CT.							

Table 15: Wepawaug River (Segment 4) Bacteria Data

Waterbody ID: CT5307-00_04

Characteristics: Freshwater, Class AA, Existing or Proposed Drinking Water Source, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 235 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **70%**

Single Sample: **94%**

Data: 2010-2011 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Wepawaug River (Segment 4) with annual geometric means calculated

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
2341	At Route 243	8/11/2010	660	dry	165
2341	At Route 243	8/26/2010	370	wet	
2341	At Route 243	9/9/2010	20	dry	
2341	At Route 243	9/14/2010	230	dry	
2341	At Route 243	9/20/2010	85	dry	
2341	At Route 243	9/22/2010	110	dry	
2341	At Route 243	9/27/2010	63	wet	
2341	At Route 243	9/29/2010	**840* (94%)**	dry	
2341	At Route 243	5/16/2011	420	dry	**415* (70%)**
2341	At Route 243	6/14/2011	410	wet	

Shaded cells indicate an exceedance of water quality criteria

†Average of two duplicate samples

**** Weather conditions for selected data taken from Hartford because local station had missing data**

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather *E. coli* (colonies/100 mL) geometric mean values for all monitoring stations on Wepawaug River (Segment 4)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
2341	At Route 243	2010	3	7	199	212	193

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gages at Tweed_New Haven_KHVN in New Haven, CT.

Table 16: Wepawaug River (Segment 5) Bacteria Data

Waterbody ID: CT5307-00_05

Characteristics: Freshwater, Class AA, Existing or Proposed Drinking Water Source, Habitat for Fish and other Aquatic Life and Wildlife, Recreation, and Industrial and Agricultural Water Supply

Impairment: Recreation (*E. coli bacteria)*

Water Quality Criteria for E. coli:

Geometric Mean: 126 colonies/100 mL

Single Sample: 235 colonies/100 mL

Percent Reduction to meet TMDL:

Geometric Mean: **90%**

Single Sample: **94%**

Data: 2010-2011 from CT DEEP targeted sampling efforts, 2012 TMDL Cycle

Single sample *E. coli* (colonies/100 mL) data from all monitoring stations on Wepawaug River (Segment 5) with annual geometric means calculated

Station Name	Station Location	Date	Result	Wet/Dry	Geomean
1060	Upstream of Route 114 crossing	8/11/2010	**3700* (94%)**	dry	**1299* (90%)**
1060	Upstream of Route 114 crossing	8/26/2010	1600	wet	
1060	Upstream of Route 114 crossing	9/9/2010	880	dry	
1060	Upstream of Route 114 crossing	9/14/2010	960	dry	
1060	Upstream of Route 114 crossing	9/20/2010	1800	dry	
1060	Upstream of Route 114 crossing	9/22/2010	1700	dry	
1060	Upstream of Route 114 crossing	9/27/2010	770	wet	
1060	Upstream of Route 114 crossing	9/29/2010	690	dry	
1060	Upstream of Route 114 crossing	5/16/2011	52	dry	131
1060	Upstream of Route 114 crossing	6/14/2011	330	wet	

Shaded cells indicate an exceedance of water quality criteria

†Average of two duplicate samples

**** Weather conditions for selected data taken from Hartford because local station had missing data**

***Indicates single sample and geometric mean values used to calculate the percent reduction**

Wet and dry weather *E. coli* (colonies/100 mL) geometric mean values for all monitoring stations on Wepawaug River (Segment 5)

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
1060	Upstream of Route 114 crossing	2010-2011	3	7	821	741	858
Shaded cells indicate an exceedance of water quality criteria							
Weather condition determined from rain gages at Tweed_New Haven_KHVN in New Haven, CT.							

REFERENCES

Costa, Joe (2011). Calculating Geometric Means. Buzzards Bay National Estuary Program. **Online**: http://www.buzzardsbay.org/geomean.htm

CTDEEP (2010). State of Connecticut Integrated Water Quality Report. **Online:** http://www.ct.gov/dep/lib/dep/water/water_quality_management/305b/ctiwqr10final.pdf

CTDEEP (2011). State of Connecticut Water Quality Standards. **Online:** http://www.ct.gov/dep/lib/dep/water/water_quality_standards/wqs_final_adopted_2_25_11.pdf

CWP (2003). Impacts of Impervious Cover on Aquatic Systems. Center for Watershed Protection. **Online**: http://clear.uconn.edu/projects/tmdl/library/papers/Schueler_2003.pdf

Eisenhower (2010). Eisenhower Park Revitalization: Milford, Connecticut, King's Mark Environmental Review Team Report. **Online:** http://www.ctert.org/ERTWebsite/pdfs/Milford_EisenhowerPark_350.pdf

Federal Register 67 (March 15, 2002) 11663-11670. Urban Area Criteria for Census 2000

Mallin, M.A., K.E. Williams, E.C. Escham, R.P. Lowe (2000). Effect of Human Development on Bacteriological Water Quality in Coastal Wetlands. Ecological Applications 10: 1047-1056.

USEPA (2001). Managing Pet and Wildlife Waste to Prevent Contamination of Drinking Water. **Online**: http://www.epa.gov/safewater/sourcewater/pubs/fs_swpp_petwaste.pdf.

USEPA (2011a). Managing Nonpoint Source Pollution from Agriculture. **Online:** http://water.epa.gov/polwaste/nps/outreach/point6.cfm

USEPA (2011b). Riparian Zone and Stream Restoration. **Online:** http://epa.gov/ada/eco/riparian.html

USEPA (2011c). Land Use Impacts on Water. Online: http://epa.gov/greenkit/toolwq.htm